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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

October 23 - October 29, 1998

Summary 98-43

Operating Experience Weekly Summary 98-43

October 23 through October 29, 1998

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EVENTS

1. CONSTRUCTION SUBCONTRACTOR SEVERS ENERGIZED 220-V LINE

On October 19, 1998, at the Idaho National Engineering Environmental Laboratory Test Reactor Area, a construction subcontractor severed an energized 220-V, 20-amp evacuation siren electrical circuit while drilling through a composite steel/masonry block wall. Facility personnel tagged the siren out of service. Investigators determined that the conduit was concealed between the exterior steel siding and the building masonry block. The facility manager directed construction personnel to stop all project construction work until further investigation and corrective actions are completed. Although no injuries resulted, failure to identify conduit before drilling caused equipment damage and could have caused personnel injury or a fatality. (ORPS Report ID--LITC-TRA-1998-0019)

Investigators determined that the construction subcontractor drilled through one layer of the masonry block wall from the interior then inspected it for any interference before he continued to drill. After he successfully drilled through the block wall, he tried to penetrate the exterior metal siding and was unable to. He then performed a visual inspection, identified metal, and assumed that the metal was the exterior siding. The subcontractor drilled a pilot hole from the building exterior, performed another visual inspection, and identified the damaged conduit. Facility personnel performed a zero-energy check, removed the siding, and checked the electrical distribution panel. They determined that the siren circuit breaker had tripped when the drill penetrated the conduit. Figure 1-1 shows an enlarged view of the damaged siren conduit on the building exterior after facility personnel removed the siding. Figure 1-2 shows the damaged siren conduit and conduit that was present on the outside of the siding. Figure 1-3 shows the interior block wall drilling location.

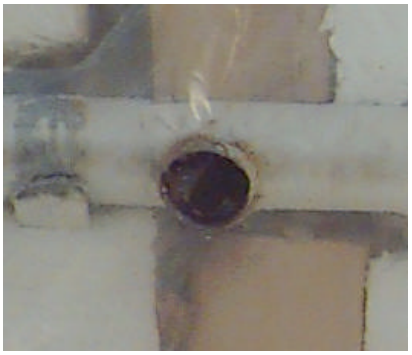

Figure 1-1. Damaged Conduit

Figure 1-2. Damaged Conduit and Exposed Conduit

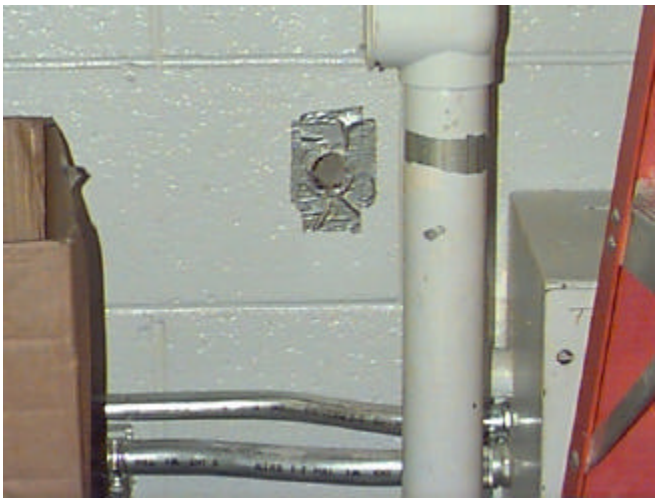

Figure 1-3. Interior Wall

Investigators determined that facility personnel had reviewed facility drawings before beginning work, but that the siren conduit was not identified on any drawings. They determined that the work plan required facility personnel to perform a subsurface investigation to ensure that no cables existed or for workers to use a drill-stop as a safety precaution. They also determined that no one had performed a subsurface investigation because the metal siding would have invalidated the results. However, the construction subcontractor failed to use the required drill-stop. Investigators determined that facility operations personnel authorized the construction subcontractor to begin work, but that no one considered removing the siding to determine if any cables were present beneath it even though conduit was visible on both sides of the wall. Investigators determined that the facility evacuation system was not compromised because siren coverage continued to be provided by other area sirens.

NFS has reported about severed conduits or cables during construction activities in several Weekly Summaries. Following are some examples.

- Weekly Summary 97-47 reported that a construction worker at the Rocky Flats Plutonium Processing and Handling Facility completely severed an energized 120-V line while core-drilling a concrete wall. Investigators determined that the subcontractor construction manager approved the core-drilling based on an exemption letter written by engineering personnel and without a technical review. They also determined that the construction manager failed to obtain engineering personnel approval before starting the core-drilling activities. (ORPS Report RFO--KHLL-371OPS-1997-0099)

- Weekly Summary 97-36 reported that a construction worker at Idaho National Engineering Environmental Laboratory cut an energized 208-V line while core-drilling a cinder-block wall to enlarge existing wall penetrations. The construction manager for the primary contractor knew that the line was on the opposite side of the wall, but he did not tell the construction worker during the pre-job briefing. The primary contractor's construction manager properly identified the drilling location on the wall, but the construction worker drilled in another location because a handrail was in the way. (ORPS Report ID--LITC-WASTEMNGT-1997-0021)

- Weekly Summary 97-35 reported that a construction worker at Idaho National Engineering Environmental Laboratory cut an energized 480-V line while saw-cutting a concrete floor. Investigators determined that the project engineer knew

that the line was under the floor but failed to recognize that it ran directly under the area where the concrete-cutting took place. The design engineer had not included a drawing showing the line location in the construction package given to the construction coordinator. The facility manager determined that the construction coordinator did not complete a subsurface survey before cutting began and that no one installed a lockout/tagout. (ORPS Report ID--LITC-SMC-1997-0005)

These events underscore the importance of using effective work control practices and detailed pre-job planning for construction activities. The responsibility for ensuring adequate planning and control of work activities resides with line management. Managers should ensure that work control processes are followed and facility practices are enforced. Safety and health hazard analysis must be included in the work control process to help prevent worker injury and should include provisions for drawing reviews, job-specific walk-downs, personnel protective equipment, and the use of equipment to detect embedded conduit. Pre-job briefings, facility procedures, and training programs should emphasize the dangers associated with excavation activities.

DOE facility managers should ensure that personnel understand the basics of work control practices and work planning. Following are some documents that facility managers should review to ensure they are incorporated in current work control programs.

- DOE O 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The Order states that work control procedures help personnel understand the necessary requirements and controls.

- DOE-STD-1050-93, *Guideline to Good Practices for Planning, Scheduling and Coordination of Maintenance at DOE Nuclear Facilities*, section 3.1.1.3, provides the key elements of an effective planning program. The standard also discusses the need for thorough reviews of work packages by experienced individuals to eliminate errors.

- DOE-STD-1073-93-Pt.1 and -Pt.2, *Guide for Operational Configuration Management Program Including the Adjunct Programs of Design Reconstitution and Material Condition and Aging Management*, states that physical configuration assessments or walk-downs should be performed for representative sample structures, systems, and components within the facility to determine the degree of agreement between the physical configuration and the configuration on the facility documentation. Physical walk-downs should be included as part of the programmatic assessments conducted during initial assessments, post-implementation assessments, and periodic effectiveness assessments.

- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that control job-associated hazards, such as physical barriers, procedural or administrative barriers, or human action. The reliability of a barrier is determined by its ability to resist failure. Barriers can be imposed in series to provide defense-in-depth and to increase the margin of safety. The guide includes a hazard-barrier matrix that shows that lockout/tagout is the most effective barrier against injury. When implemented properly, lockout/tagout provides a high probability (greater than 99 percent) of success for risk reduction. The guide provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards. A copy of the *Hazard and Barrier Analysis Guide* is available from the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874.

KEYWORDS: work control, hazard analysis, electrical safety

FUNCTIONAL AREAS: Work Control, Construction, Industrial Safety

2. TURBINE GENERATOR WORK PERFORMED WITHOUT A LOCKOUT/TAGOUT AT ROCKY FLATS

On October 20, 1998, at the Rocky Flats Environmental Technology Site Plutonium Processing and Handling Facility, a facility manager reported that a building maintenance machinist and a vendor representative had performed work on a turbine generator without a lockout/tagout in place. A DOE Facility Representative was reviewing the work and asked a contractor technical representative engineer if a lockout/tagout had been installed before work began. The contractor technical representative engineer confirmed that no lockout/tagout had been applied. The facility manager terminated all turbine generator work and directed facility personnel to install a lockout/tagout on it. The site integrating contractor issued a sitewide standing order for facility personnel to review and document all maintenance work packages for lockout/tagout compliance. Although there were no injuries from this incident, installing a lockout/tagout would have provided a positive barrier to protect workers from a rotating equipment hazard. (ORPS Report RFO--KHLL-371OPS-1998-0077)

Investigators determined that facility personnel noticed abnormal vibration and noise while performing a post-maintenance test of the turbine generator, and they immediately shut it down. The post-maintenance test was required following replacement of a frequency meter. Facility personnel declared the generator inoperable and developed a troubleshoot- and-repair work package for a vendor representative to disassemble and repair it. The facility manager, a shift technical advisor, and utilities personnel discussed locking out and tagging out the generator when it was declared inoperable. The facility manager and the shift technical advisor assumed after the discussion that utilities personnel would apply a lockout/tagout to protect the generator from equipment damage, but no one installed the lockout/tagout. Investigators determined that before performing work the vendor asked an engineer if a lockout/tagout was installed. They determined that the engineer told the vendor a lockout/tagout was installed because he observed an illuminated “not ready” light and believed that this was an indication that the generator was locked out and tagged out. However, no one performed a physical verification to ensure if a lockout/tagout was installed. Investigators determined that the contractor technical representative engineer was not qualified to oversee the work being performed. They also determined that the maintenance supervisor and the contractor technical representative engineer did not ensure that the troubleshoot and repair work package was followed because no one signed off for the lockout/tagout steps that were specified in the work package.

The facility manager held a fact-finding meeting. Meeting attendees learned that for this troubleshoot-and-repair work package, craft personnel developed the appropriate steps as they worked. They also learned that some troubleshoot-and-repair work package steps are not routinely developed and approved by engineering personnel. Attendees learned that the maintenance machinist and the vendor did not document the troubleshoot-and-repair work package steps that they had completed and that the responsible engineer did not approve the work before they performed it. The facility manager developed the following corrective actions.

- The facility manager will train shift managers and shift technical advisors on his lockout/tagout expectations for failed equipment.
- The facility manager will train engineering support and maintenance personnel on his expectations and the intent of troubleshoot-and-repair work packages.

- The facility manager will train stationary operating engineers on equipment lockout/tagout requirements.

- Maintenance supervisors will ensure that qualified contractor technical representatives are assigned to oversee vendor work.

- Industrial hygiene personnel will evaluate changing health and safety practices to specifically require verification that lockouts/tagouts are in place before performing work.

- Industrial hygiene personnel will train contractor technical representatives on the required vendor lockout/tagout training requirements.

NFS has reported inadequate work control programs in several Weekly Summaries. Following are some examples.

- Weekly Summaries 98-36 and 98-21 reported that an electrician at the Kansas City Plant received second- and third-degree flash burns from an electrical arc blast while cleaning a 13.8-kV switch at an outdoor substation. A Type B Accident Investigation Board identified the root cause of the event as lack of effective work integration and failure to responsibly implement the high-voltage work control process. (*Type B Accident Investigation Board Report on the May 24, 1998, Electrical Arc Blast at the Kansas City Plant*, July 1998; and ORPS Report ALO-KC-AS-KCP-1998-0010)

- Weekly Summaries 98-22 and 98-13 reported that an electrician at the Ames Laboratory Technical and Administrative Services Facility was severely injured when part of his clothing became entangled with a rotating shaft on a supply fan. The electrician was airlifted to a regional hospital, where doctors performed lifesaving surgery, as well as subsequent surgery to save his arms. A Type B Accident Investigation Board identified failure to identify the exposed rotating shaft hazard and lack of an integrated safety management program as the root causes of the event. (DOE/CH-AI98E, *Type B Accident Investigation Board Report on the March 27, 1998, Rotating Shaft Accident at Ames Laboratory Ames, Iowa*, April 1998; ORPS Report CH--AMES-AMES-1998-0002)

These events underscore the importance of using an integrated approach to safety that stresses clear goals and policies, individual and management accountability and ownership, implementation of requirements and procedures, and thorough and systematic management oversight. The responsibility for ensuring adequate planning and control of work activities resides with line management. Managers should ensure that work control processes are followed and facility practices are enforced. Safety and health hazard analyses must be included in the work control process to help prevent worker injury. The hazard analysis process should include provisions for lockouts/tagouts, job-specific walk-downs, integration of work activities, and personnel protective equipment. Pre-job briefings, facility procedures, and training programs should emphasize the dangers associated with mechanical activities. Plan-of-the-day meetings or pre-job briefings should be held so that work organization responsibilities are clearly defined and the expectations of the task are understood.

Personnel at DOE facilities should have a continually questioning attitude toward safety issues. Each individual is ultimately responsible for complying with rules to ensure personal safety. Facility managers should communicate the idea that safety is of prime importance and that all personnel must be committed to excellence and professionalism.

DOE facility managers should ensure that personnel understand the basics of work control practices and work planning. Following are some documents that facility managers should review to ensure they are incorporated in current work control programs.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, states that DOE policy is to operate DOE facilities in a manner to assure an acceptable level of safety and to ensure procedures are in place to control conduct of operations. Chapter VIII, "Control of Equipment and System Status," provides an overall perspective on control of equipment and system status. Specific applications of system control are addressed in chapter IX, "Lockout/Tagout," and chapter X, "Independent Verification."

- DOE O 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The Order states that work control procedures help personnel understand the necessary requirements and controls. Section 3.4 identifies the elements of a maintenance management program that ensure planning, control, and documentation of maintenance.

- DOE G 450.4-1, *Integrated Safety Management Guide*, provides extensive guidance to DOE contractors for developing, describing, and implementing an integrated safety management system to comply with DOE policy and acquisition rules. The guide addresses core functions and guiding principles related to defining scope of work, analyzing hazards, developing and implementing controls, and performing work at the facility, project, or activity level.

- DOE-STD-1120-98, *Integration of Environment, Safety, and Health into Facility Disposition Activities*, provides guidance for enhancing worker, public, and environmental safety. This standard supports integrated safety management system principles to guide the safe accomplishment of work activities, which include (1) line management responsibility for safety; (2) clear roles and responsibilities; (3) competence commensurate with responsibilities; (4) balanced priorities; (5) identification of safety standards and requirements; (6) hazard controls tailored to work being performed; and (7) operations authorization.

- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that control job-associated hazards, such as physical barriers, procedural or administrative barriers, or human action. The reliability of a barrier is determined by its ability to resist failure. Barriers can be imposed in series to provide defense-in-depth and to increase the margin of safety. The guide includes a hazard-barrier matrix that shows that lockout/tagout is the most effective barrier against injury. When implemented properly, lockout/tagout provides a high probability (greater than 99 percent) of success for risk reduction. The guide provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards.

Integrated safety management information can be found at the Safety Management website, http://tis-nt.eh.doe.gov/ism. DOE technical standards can be found at http://www.doe.gov/html/techstds/standard/standard.html. A copy of the *Hazard and Barrier Analysis Guide* is available from the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Additional information on lockout/tagout can be found in article 3.

KEYWORDS: job planning, lockout and tagout, maintenance

FUNCTIONAL AREAS: Industrial Safety, Work Control, Hazard and Barrier Analysis

3. LOCKOUT PERFORMANCE CONCERNS AT SAVANNAH RIVER

This week, OEAF engineers reviewed two recent lockout/tagout events at Savannah River. On October 21, 1998, personnel performing a 100 percent walk-down audit of lockouts at the In-Tank Precipitation Facility discovered that although a breaker had been tagged correctly by a lockout installer, the lockout verifier installed the lockout device on an adjacent breaker. The operations manager immediately stopped work already in progress under the lockout. On October 27, 1998, the facility manager for the Savannah River Consolidated Incinerator Facility prohibited lockout activity until a briefing is held for all lockout installers. The facility has experienced four occurrences since August 1998 and five since April 1998. Although facility personnel have taken corrective actions in response to each occurrence, the current trend in lockout problems indicates that further action is needed. (ORPS Reports SR--WSRC-ITP-1998-0053 and SR--WSRC-CIF-1998-0013)

The Consolidated Incinerator Facility has experienced the following lockout problems since April 1998. NFS has reported on one of them.

- On April 14, 1998, maintenance personnel discovered voltage on a temperature switch that was locked out for replacement. A shift manager had signed the lockout to indicate it established adequate worker safety. Investigators determined that a newly assigned writer failed to include a requirement for a voltage check as a condition of the shift manager's approval because he did not understand the purpose of the step. They also determined that the shift manager had forgotten the requirement for a voltage check. (ORPS Report SR--WSRC-CIF-1998-0003 and OEWS 98-16)

- On August 10, 1998, operators who were flushing pH probes on a pump discharge pipe observed flush water flowing from an opening created when maintenance personnel removed a pump discharge valve earlier in the day. The operators had closed a pH probe isolation valve before beginning the flush, but the valve leaked by the seat. Investigators determined that work planners had inappropriately removed pH probe isolation valves from a lockout plan when they revised it to accommodate concurrent work. They also determined that work planners did not review facility configuration to ensure that the lockout would be adequate for all activities planned in the vicinity of the pump discharge. (ORPS Report SR--WSRC-CIF-1998-0007)

- On September 9, 1998, a maintenance supervisor conducting a lockout acceptance walk-down discovered that a lockout tag was hung on the wrong valve. Although the locked-out valve was one of two in-line valves, either of which provides adequate isolation, both the person who hung the tag and the person who verified the tag failed to compare the lockout order requirement with the lockout tag and the component label. (ORPS Report SR--WSRC-CIF-1998-0009)

- On October 16, 1998, a supervisor walking down a lockout discovered a valve in the wrong position. Investigators determined that an extension rod for the valve positioner had split and ratcheted on the valve shaft, leaving the valve in the open position even though the positioner indicated it was closed. Insulation around the valve obscured the failure. Facility personnel discovered another failure of this type during an inspection of all similar valves. (ORPS Report SR--WSRC-CIF-1998-0012)

- On October 27, 1998, personnel in the vicinity of a ball valve noticed that two links in a steel chain used to lock out the valve handle were joined with a plastic tie-wrap. The valve was part of an administrative lockout to prevent cross-contamination during testing of an interconnecting system. Investigators determined that the lockout installer had not adequately inspected the chain before using it. This event prompted notification of the adverse lockout/tagout performance trend.

OEAF engineers searched the ORPS database[1] for occurrences involving inadequate lockouts/tagouts and identified 197 occurrences. Facility managers cited personnel error as the direct cause for 165, or 84 percent, of these occurrences. Procedure not used or used incorrectly accounted for 67 percent of personnel errors, and inattention to detail accounted for 22 percent. Figure 1-1 illustrates the annual frequency of lockout/tagout events systemwide normalized to manhours. Data for 1998 is extrapolated. The data shows a steady increase in frequency since 1996, following a decline from 1994 to 1996.

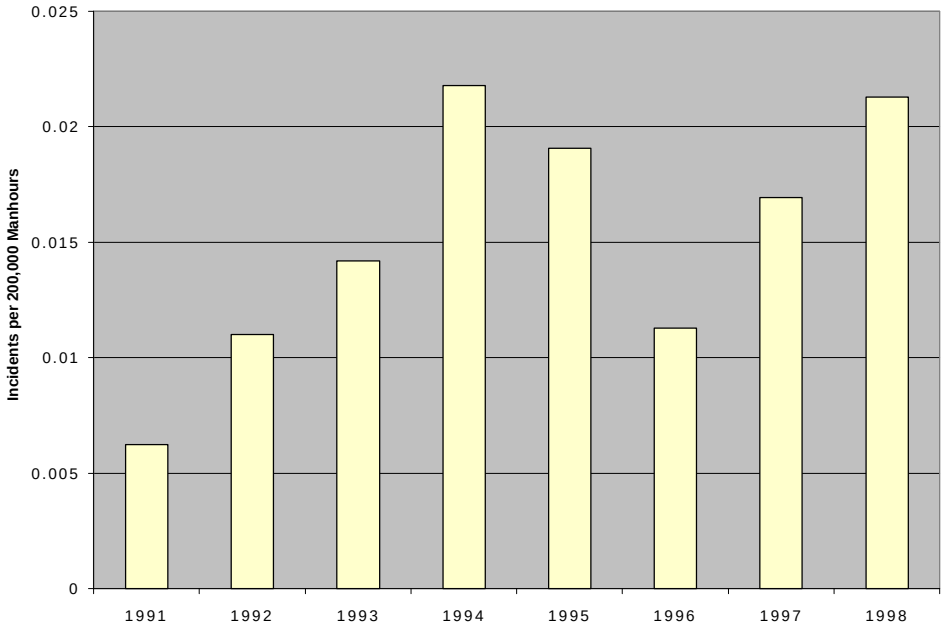

Figure 1-1. Annual Distribution of Lockout /Tagout Events

[1] OEAF engineers searched the ORPS database for all occurrence narratives containing "(lockout* OR tagout* OR LOTO OR LO/TO) AND (improper OR inadequat* OR violat*)" and identified 253 occurrences. A 100 percent review of these yielded 197 occurrences involving inadequate lockouts/tagouts.

These events underscore the importance of an effective lockout/tagout program conscientiously applied by trained personnel. Although the frequency of lockout/tagout problems is low compared to the volume of lockout/tagout activity across the system, the tolerance for problems is also very low. Each instance of lockout/tagout inadequacy has the potential to cause personnel injury, equipment damage, or operational problems. Lockout/tagout programs in DOE serve two functions. The first function, defined in 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities,* is to protect personnel from injury and equipment from damage. The second function is to provide overall control of equipment and system status. The standard states that an effective lockout/tagout program requires three elements: (1) all affected personnel must understand the program; (2) the program must be applied uniformly in every job; and (3) the program must be respected by every worker and supervisor.

Facility and site managers at all DOE sites should conduct thorough reviews of their lockout/tagout programs to identify potential obstacles to effective lockouts. These obstacles include opportunity for errors in establishing lockout boundaries, developing lockout procedures or orders, installing and checking lockout tags and lockout devices, review by approval authorities, walk-downs by worker supervisors, and zero-energy checks before work begins. Facility and site managers should also examine ways to enhance attention to detail when implementing or accepting lockouts. Lockout/tagout issues and practices should be incorporated into initial training programs for all employees and should be emphasized through safety meetings, pre-job briefings, and periodic retraining. Training for all contractor and subcontractor personnel should emphasize the individual's right to question safety or perform independent checks.

DOE/EH-0540, Safety Notice No. 96-05, *Lockout/Tagout Programs*, summarizes lockout/tagout events at DOE facilities, provides lessons learned and recommended practices; and identifies lockout/tagout program requirements. DOE/EH-0502, Safety Notice 95-02, *Independent Verification and Self-Checking*, provides guidance and good practices for performing independent verification. Safety Notices can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd, Germantown, MD 20874. They are also available on the OEAF website at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

KEYWORDS: lockout and tagout, safety, work planning

FUNCTIONAL AREAS: Industrial Safety, Operations, Training and Qualification

4. SOIL-STRUCTURE INTERACTION MODELING ERRORS RESULT IN A POSITIVE UNREVIEWED SAFETY QUESTION

On October 26, 1998, at the Idaho National Engineering Environmental Laboratory Fuel Storage Area, a facility manager reported a potential misapplication of a System for Analysis of Soil-Structure Interaction (SASSI) computer code used as part of the facility seismic analysis, resulting in an positive unreviewed safety question. Investigators determined that some SASSI modeling techniques result in incorrect structural stiffness values being assigned to geometric reference nodes, resulting in SASSI calculating nonconservative member stresses for internal structures. OEAF engineers recommend that facility personnel who perform seismic analysis using SASSI should determine if their facility or site could be affected by a modeling technique error. (ORPS Report ID--LITC-FUELRCSTR-1998-0016)

Investigators have developed screening criteria that will allow facility personnel to determine if the modeling error could affect their facility. They have determined that if the facility design basis seismic analysis meets any of the following six criteria, then the analysis results will not be affected or will not be significantly affected.

- structures with no internal basement structures
- structures with internal structures not attached to soil-structure interaction nodes
- structures with rigid basements and internal basement structures that do not use the stress results calculated by SASSI (including analyses where response spectra are computed and subsequently used to compute demands on internal structures)
- analyses that are modeled using the skin method
- analyses for surface structures
- analyses that model a physical connection to the boundary nodes between the structure and the soil

All other analyses using SASSI should be evaluated on a case by case basis.

NFS has reported on safety analysis deficiencies in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-30 reported that a facility manager at the Savannah River H-Canyon Facility reported that Westinghouse personnel identified an incorrect facility safety analysis default assumption in the MELCOR Accident Consequence Code System (MACCS) used to calculate dose consequences. Investigators determined that although the limiting radionuclide at H-Canyon is plutonium nitrate, MACCS calculates dose consequences using a default radionuclide table for plutonium oxide. They determined that dose consequence analysis results increase by approximately 50 percent when a plutonium nitrate radionuclide table is used instead of a plutonium oxide table. (ORPS Report SR--WSRC-HCAN-1998-0021)

- Weekly Summary 97-39 reported that the Facility Plant Review Committee at a Hanford reprocessing facility reported an unreviewed safety question because ventilation system modifications made in 1969 were not in accordance with the safety analysis report. The committee agreed that the modifications would cause the filters to collapse during a design basis fire, leading to an unfiltered radioactive release through the main stack. The failure of the filters did not match the accidents analyzed in the safety analysis report. (ORPS Reports RL--PHMC-324FAC-1997-0010 and RL--PHMC-324FAC-1997-0014)

- Weekly Summary 95-32 reported that, at Pacific Northwest Laboratories, the seismic response of a building had not been analyzed because of an error in a seismic analysis performed in 1990. The analyst used a computer program that can apply either velocity or acceleration spectrum data to model seismic response. The analyst used acceleration data but omitted a switch value, causing the input to be treated as velocity data (the default). The resulting error was not detected by quality control procedures, and the analysis was subsequently used as the basis for seismic qualification of the building. (ORPS Report RL--PNL-324-1995-0015)

These events illustrate the importance of thoroughly reviewing all accident assumptions as part of the facility safety analysis report. Analysis assumptions should be delineated in the facility authorization bases so that safety questions can be adequately evaluated and any operating assumptions can be translated into procedures. These events also point out the importance of verification and validation of software programs. These reviews are necessary to ensure that facilities are not operated or placed in unsafe conditions. In addition, periodic reviews of safety

documentation should focus on analysis assumptions to ensure they remain valid under all conditions, especially when facilities change or add missions.

Facility managers should ensure that safety analyses are independently verified and audited to provide confidence that they adequately reflect operational, functional, and technical requirements. Personnel who perform accident analyses should have a thorough understanding of all code aspects, as these codes can be complex. Also, they should not use default parameters in their analyses without ensuring the validity of these parameters for the scenario being evaluated. Facility managers should also ensure that personnel responsible for reviewing and updating facility safety analysis reports verify that analysis data is accurately presented and that the analyzed hazards are the appropriate ones for the facility.

- DOE O 1330.1D, *Computer Software Management*, provides guidance for establishing a computer software management program, including quality assurance and quality control.

- DOE O 1360.4B, *Scientific and Technical Computer Software*, provides guidance for the management and control of scientific and technical software.

- DOE O 5480.23, *Nuclear Safety Analysis Reports,* states that it is DOE policy to analyze nuclear facilities and operations to (1) identify all hazards and potential accidents associated with the facility and the process systems, components, equipment, or structures; and (2) establish design and operational means to mitigate these hazards and potential accidents. The results of these analyses are to be documented in safety analysis reports. This Order also requires periodic review and updates of safety analysis reports to ensure that information is current and remains applicable.

- DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports,* provides a graded approach to the preparation of safety analysis reports for nuclear facilities. The standard discusses the facility's stage in its life cycle and states that all safety analysis reports should furnish information about subsequent stages of the facility life cycle, including end-of-life decontamination and decommissioning.

- DOE/EH-0502, Safety Notice 95-02, *Independent Verification and Self-Checking*, September 1995, provides guidance and good practices for performing independent verification. Safety Notice 95-02 can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to U.S. Department of Energy, ES&H Information Center, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Safety Notices are also available at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html.

SASSI users can contact Tom Huston of Structural Dynamics Engineering at (706) 849-0670 for additional information.

KEYWORDS: safety analysis, accident analysis, authorization basis

FUNCTIONAL AREAS: Licensing/Compliance, Nuclear/Criticality Safety, Technical Support

5. CONTAMINATED CYLINDER FOUND AT ROCKY FLATS

On October 21, 1998, at the Rocky Flats Environmental Technology Site Solid Waste Treatment Facility, radiological control technicians discovered a contaminated gas cylinder containing unknown contents that had been stored on the facility loading dock for over one year. They measured 9,600 dpm/100 cm^2 removable alpha contamination on the cylinder valve threads and handle while performing routine surveys to release excess chemicals for disposal. Facility personnel moved the cylinder to a contamination area inside the facility until its contents are sampled and an appropriate method of disposal developed. They also isolated the cylinder to preclude hazardous interactions. Radiological control technicians surveyed the loading dock and did not identify any additional contamination. Failure to properly implement the safety review process for this activity resulted in noncompliance with radiological control procedures, created a potential fire hazard, and created a potential chemical safety hazard. (ORPS Report RFO--KHLL-SOLIDWST-1998-0027)

Investigators determined that sometime during 1997, the facility manager approved the removal of legacy chemicals from the facility. The manager believed that Waste Management personnel would locate the chemicals within the facility, identify them, and immediately ship them to proper disposal locations. After beginning the project, Waste Management personnel moved the cylinder onto the loading dock, which they established as a “less than 90-day waste accumulation area” to facilitate storage, characterization, and removal of the chemicals from the facility. Investigators determined that the facility manager was not informed of this action and had not approved the loading dock as a storage location. They also determined that storing the cylinder constituted a new activity and that no one had reviewed the activity, as required by facility safety review process procedures. Therefore, no one had performed an unreviewed safety question determination or evaluated any potential hazards before storing the cylinder. Waste Management personnel did not initiate the safety review process because they knew that the chemical removal activity was approved, and they did not consider the impact of a new storage area on potential fire or chemical hazard requirements. Investigators determined that the cylinder was originally stored in the facility and that its specific contents and usage history have been lost. They also learned that using the dock for long-term storage presented the potential for a variety hazards (such as storage in a non-climate-controlled environment, chemical degradation, potentially explosive or toxic chemical releases, or fires) in addition to the identified contamination hazard.

NFS has reported improper material storage events in several Weekly Summaries. Following is an example and an additional example that was reported to the ORPS database.

- Weekly Summary 98-15 reported that a fire protection engineer at the Los Alamos National Laboratory Chemistry and Metallurgy Research Facility determined that a temporary storage shed used to stage legacy chemicals was not in compliance with National Fire Protection Association (NFPA)-80A requirements because it was located too close to the facility. Waste Management personnel placed the shed near the facility and staged the chemicals in it until they could be shipped to proper disposal locations. Investigators determined that no one performed a hazards assessment for this activity to determine if chemical storage requirements would be met. (ORPS Report ALO-LA-LANL-CMR-1998-0012)

- On March 17, 1998, at Rocky Flats Environmental Technology Site Plutonium Processing and Handling Facility, a facility manager reported that wooden low-level waste crates were stored outside the facility and that no one had performed a safety analysis to evaluate the potential hazards. Fire protection personnel were concerned that a variety of storage requirements were not being met, including those for (1) combustible loading, (2) minimum distances between crates, and (3) minimum distances between the crates and the facility. The facility manager directed facility personnel to perform an unreviewed safety question determination

and relocate the crates to an acceptable location. (ORPS Report RFO--KHLL-779OPS-1998-0009)

These events underscore the importance of evaluating all hazards when removing hazardous legacy chemicals or waste from facilities. Managers of facilities that generate, receive, store, and ship chemicals must develop appropriate programs and procedures to identify all associated hazards. Facility managers should provide workers with the necessary information to ensure accurate and complete evaluations. Risks should be evaluated, and barriers should be put in place to reduce them. New activities and job scope changes need to be thoroughly reviewed, and the impact on the design and facility authorization bases should be evaluated. The Rocky Flats event also illustrates the importance of ensuring that managers are informed of operations that may affect the facility. In this event, facility management changes affected the cylinder sampling and disposal priority, resulting in its history being lost and its being improperly stored. If specific work plans had been in place, the cylinder might not have been improperly stored for over one year.

Facility managers should review the following documents to ensure that practices and procedures are properly implemented and provided for in the facility authorization bases.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter II, "Shift Routines and Operating Practices," states that the on-duty shift supervisor should maintain authority and responsibility for all facility operations. Facility managers should also be informed of work that they are ultimately responsible for.

- DOE O 5480.23, *Nuclear Safety Analysis Reports*, requires performing a hazard analysis to ensure comprehensive, integrated, and balanced risk management of all safety and environmental hazards. Section 3 requires analyses of expected releases, exposures, and accidents. It also requires consideration of residual risks to ensure that the risks and consequences of operation are acceptable and conform with safety design objectives.

- NFPA-80A, *Recommended Practice for Protection of Buildings from Exterior Fire Exposures*, provides recommendations to protect buildings from exterior fire hazards. It includes methods to determine necessary separation distances between buildings and potential ignition sources. NFPA codes and standards ordering information can be found on the NFPA Home Page at http://www.nfpa.org/.

- The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that provide controls over hazards associated with a job. The guide provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards. A copy of the *Hazard and Barrier Analysis Guide* is available at http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf.

Information about chemical hazards can be found at http://tis-hq.eh.doe.gov/web/chem_safety/. This website provides links to many sources of information, including requirements and guidelines, lessons learned, chemical safety networking, and chemical safety tools.

KEYWORDS: fire protection, chemical, hazard analysis, work control

FUNCTIONAL AREAS: Hazards and Barrier Analysis, Work Planning, Fire Protection, Materials Handling/Storage

OEAF FOLLOW-UP ACTIVITY

1. LESSONS LEARNED FROM THE TYPE A INVESTIGATION OF A CARBON DIOXIDE DISCHARGE RESULTING IN A FATALITY AND INJURIES

On July 28, 1998, at the Idaho National Engineering and Environmental Laboratory, a high-pressure carbon dioxide (CO_2) fire suppression system unexpectedly actuated in Building 648 at the Test Reactor Area. The accident resulted in one fatality, several life-threatening injuries, and significant risk to the safety of the initial rescuers. Investigators determined the direct cause was the inadvertent operation of electric control heads that released CO_2 into the occupied space without a discharge warning alarm. NFS reported the event in Weekly Summaries 98-30, 98-33, and 98-38. In September 1998, The Office of Oversight for Environment, Safety and Health issued a Type A Accident Investigation Board Report on the accident that identified two root causes. First, Lockheed Martin Idaho Technologies Company (LMITCO), the site operating contractor, did not have a systematic method for identifying, institutionalizing, or implementing requirements for the design, installation, and work conducted on or affected by the CO_2 fire suppression system. Second, DOE Idaho Operations Office (ID) and LMITCO management had accepted unstructured work controls, which helped to increase industrial safety risks to workers. This accident highlights the importance of a comprehensive approach to safety. Site safety programs should stress (1) clear goals and policies, (2) individual and management accountability and ownership, (3) implementation of requirements and procedures, and (4) thorough and systematic oversight by contractor and DOE management. (Weekly Summaries 98-30, 98-33, and 98-38; Type A Accident Investigation Board Report on the July 28, 1998, Fatality and Multiple Injuries Resulting from the Release of Carbon Dioxide at Building 648, Test Reactor Area, Idaho National Engineering and Environmental Laboratory; ORPS Report ID--LITC-TRA-1998-0010)

Workers were de-energizing electrical circuit breakers in preparation for preventive maintenance on the electrical system in Building 648. Thirteen people were in the building, including foremen, operators, electricians, and fire protection personnel. When a worker opened the last circuit breaker, the CO_2 fire suppression system unexpectedly discharged without an evacuation warning alarm. Within seconds, the workers found themselves struggling to escape the potentially lethal atmosphere under near-zero visibility and the disorienting effects of CO_2. Pathway obstacles, the failure to have designated emergency exit paths, and inadequate exit path lighting also impeded their escape. Initial rescue efforts were hampered by the absence of readily available self-contained breathing apparatuses, forcing responders to risk their lives to save fellow workers. In all, 15 personnel received medical treatment or evaluation as a result of the accident. Of the 14 survivors, 11 were released from the hospital and 3 were admitted with serious injuries.

The Accident Investigation Board determined that the accident was avoidable. The CO_2 system was not physically locked out to protect the workers, as was required. Such a lockout could have prevented this accident. However, the procedure that required this barrier had not been updated or used for this work. There also was a requirement to train workers in the hazards of emergency response to CO_2 discharges, but this requirement had not been incorporated into training programs. The workers were not sufficiently aware of the hazard, emergency response measures, or the limitations of the protection provided. LMITCO relied excessively on the pre-discharge warning alarm, which was never received, and on electronic impairment of the fire panel to protect the workers. The workers did not have the means to safely escape, including clear exit pathways, breathing apparatus, emergency exit training, exit pathway lighting, and

emergency ventilation. The CO_2 system design, as installed in 1971 and as modified in 1997, did not have the required monitoring of system status to ensure at least a 25-second warning alarm regardless of the source of actuation.

The use of CO_2 as an extinguishing agent does not come without risks. The concentration of CO_2 needed to extinguish fires is many times greater than the lethal concentration. Investigators determined that the percentage of CO_2 in the building following the discharge was approximately 50 percent. This is well above the 30 percent minimum concentration necessary for fire protection and was potentially lethal to the occupants. At 50 percent CO_2, the oxygen levels in the building would be approximately 10.5 percent, well below that needed to sustain life. Once discharge begins, evacuation becomes difficult because of reduced visibility, loud noise, and disorientation from physiological effects. Figure 1-1 shows the physiological effects of CO_2 exposure.

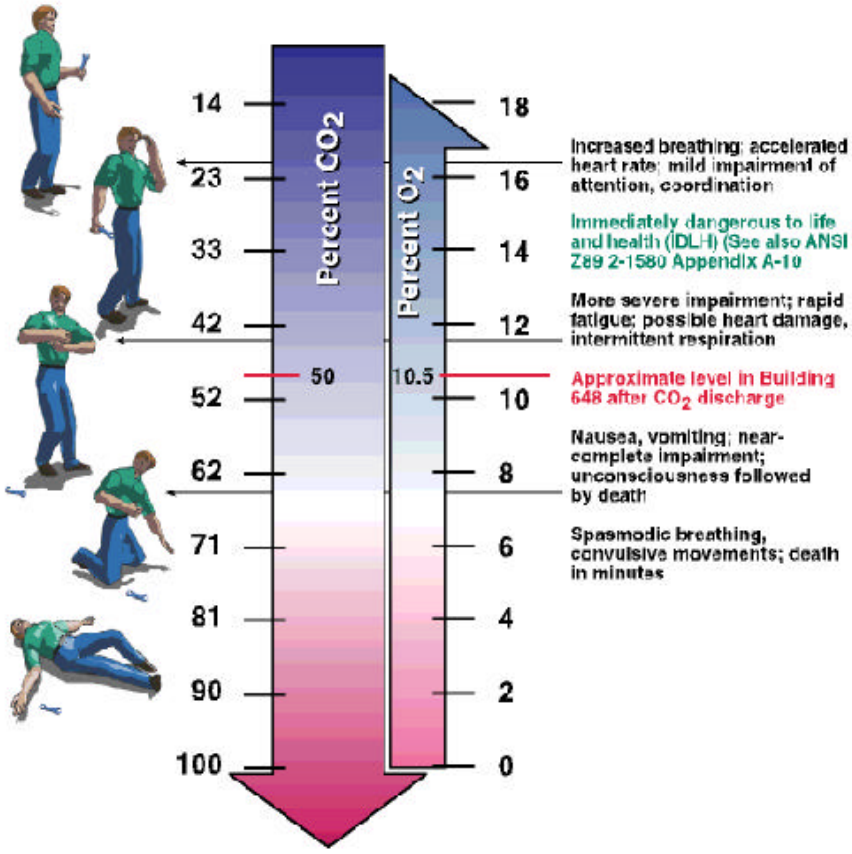

Figure 1-1. Physiological Effects of CO_2 Exposure

The Accident Investigation Board identified the following contributing causes.

- Failure to implement appropriate quality assurance requirements and procedures resulted in faulty system design and installation. Also, the failure to install a monitoring or feedback circuit on the CO_2 discharge header or a solenoid valve position input to the discharge alarm meant that the workers could not be warned of the CO_2 actuation and imminent discharge.

- Failure to use physical (lockout/tagout) and administrative barriers (current procedures and work planning and control processes) that would have complied with regulatory requirements.

- Failure to assure that staff at all levels were competent to deal with the CO_2 hazards. Those involved with the CO_2 fire suppression system did not understand the requirements and procedures at the design, work planning and control, and implementation stages of the work at the sitewide, facility, and activity levels.

- Failure to take corrective actions and apply lessons learned from previous accident investigations, particularly in work planning and control. ID and LMITCO also failed to sufficiently monitor the process and obtain the feedback needed to correct major safety deficiencies that impacted worker safety.

- Failure to identify, institutionalize, and implement requirements for immediate emergency rescue and response to planned and unplanned CO_2 discharges.

- Failure to adequately evaluate the impact of incremental cost cutting and infrastructure reductions on worker safety.

The Board concluded that ID did not aggressively or effectively monitor contractor performance or adherence to requirements, or ensure that corrective actions and improvements in hazard and work controls had been completed and were being consistently applied. The Board also found that LMITCO did not fulfill its contractual obligation to protect workers from a potentially lethal hazard by putting in place the requisite design, policies, procedures, hazard analysis, work controls, communications, personal protective equipment, positive system lockout, and training. The contractor failed to prevent actuation of the CO_2 system or, alternatively, to ensure adequate warning and escape time and the ability to carry out immediate search and rescue without risking additional lives.

The primary purpose of accident investigations is to learn what occurred and to apply that knowledge to prevent recurrence. According to DOE-STD-1045-83, *Guide to Good Practices for Notifications and Investigation of Abnormal Events*, operations managers, supervisors, and members of safety review committees should review accident investigation reports and ensure that lessons learned from events are identified and incorporated into facility programs. NFS recommends that managers with facilities that use CO_2 fire suppression systems review this Type A Accident Investigation Board Report and its judgements of need. The Type A Accident Investigation Board Report on this event is available at http://tis.eh.doe.gov/oversight/acc_inv/acc_investigations.html.

KEYWORDS: carbon dioxide, electrical maintenance, fatality, fire retardant

FUNCTIONAL AREAS: Electrical Maintenance, Fire Protection, Industrial Safety

PRICE-ANDERSON AMENDMENTS ACT (PAAA) INFORMATION

1. PRELIMINARY NOTICE OF VIOLATION AT IDAHO

On September 21, 1998, the DOE Office of Enforcement and Investigation issued a Preliminary Notice of Violation and Proposed Imposition of Civil Penalty of $55,000. The notice describes the facts and circumstances concerning the unauthorized disabling of the seismic scram subsystem discovered in October 1997 and surveillance deficiencies occurring in October 1997 at the Advanced Test Reactor Critical (ATRC) Facility. It states that in accordance with the "General Statement of Enforcement Policy," 10 CFR 820, Appendix A (effective November 7, 1997), DOE proposes to impose civil penalties pursuant to Section 234A of the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2282a, and 10 CFR 820. (NTS-ID--LITC-ATR-1997-0005 and NTS-ID--LITC-ATR-1998-0001)

Section I of the Preliminary Notice of Violation describes a violation of DOE's nuclear safety requirements associated with the disabled seismic scram subsystem. The subsystem, which is required by the facility technical specifications to be functional during reactor operations, was disconnected by person(s) unknown during an unauthorized activity. Investigators believe that the reactor was operated on three occasions with the seismic subsystem disabled. Operating the reactor without the subsystem functional represented multiple work control and procedural breakdowns in the Quality Assurance Rule (10 CFR Part 830.120). The Office of Enforcement and Investigation staff classified this as a Severity Level II problem with a base civil penalty of $55,000. The penalty was waived based on the contractor's timely identification of the problem and reporting of the violation and its comprehensive corrective actions.

Section II of the Preliminary Notice of Violation describes violations of DOE's nuclear safety requirements pertaining to surveillance of the ATRC Facility. These violations include (1) failure to properly conduct pre-start-up surveillance activities designed to ensure safe shutdown capability of the facility, (2) preparation of false records, and (3) failure to promptly initiate corrective action documentation. Investigators discovered that three surveillances could not have been completed on the dates and times recorded on the procedures because one of the two operators designated on the maintenance procedures was not in the ATRC Facility at the times indicated. Office of Enforcement and Investigation staff determined that the contractor did not promptly report these surveillance deficiencies into DOE's Noncompliance Tracking System and that substantial prior opportunity to identify and resolve the problem existed. The Office of Enforcement and Investigation staff classified these violations as a Severity Level II problem with a base civil penalty of $55,000. In a letter dated October 19, 1998, the contractor accepted the Preliminary Notice of Violation and paid the civil penalty.

NFS has reported recent Notices of Violations under the Price-Anderson Amendments Act in Weekly Summaries 98-42, 98-41, 98-40, 98-26, 98-15, and 98-11.

Under the provisions of the Price-Anderson Amendments Act, DOE can fine for-profit contractors and subcontractors for violations of Department rules, regulations, and compliance orders relating to nuclear safety requirements. DOE contractors who operate nuclear facilities or perform nuclear activities and fail to remain in compliance with such requirements could be subjected to Price-Anderson civil penalties under the work processes and quality improvement provisions of 10 CFR 830.120, *Quality Assurance Requirements,* and/or 10 CFR 835, *Occupational Radiation Protection*. These actions include Notices of Violation and, where appropriate, nonreimbursable civil penalties.

The primary consideration for determining whether DOE takes enforcement action is the actual or potential safety significance of the violation, coupled with how quickly the contractor acts to identify and correct problems. The Office of Enforcement and Investigation may reduce penalties when a DOE contractor promptly identifies a violation (before it results in an undesirable event), reports it to DOE, and undertakes timely corrective action. DOE has the discretion to decide not to issue a Notice of Violation in certain cases.

The Noncompliance Tracking System (Weekly Summaries 95-17 and 95-20) provides a means for contractors to promptly report potential noncompliances and take advantage of provisions in the enforcement policy. DOE-STD-7501-95, *Development of DOE Lessons Learned Programs*, discusses management responsibility for incorporating appropriate corrective actions in a timely manner.

KEYWORDS: enforcement, Price-Anderson Act, quality assurance, surveillance

FUNCTIONAL AREAS: Lessons Learned, Management, Surveillance